

Solar Cycle & Temperature Trends: *AIRS Data at 400 hPa*

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A Challenge

Mid-Tropospheric Temperature is sensitive to:

- CO₂
- SST (Pacific and Atlantic Multi-Decadal Oscillations)
- Solar Irradiance
- ...

Study temperature response in region 0-20°N using 5 yrs of AIRS data

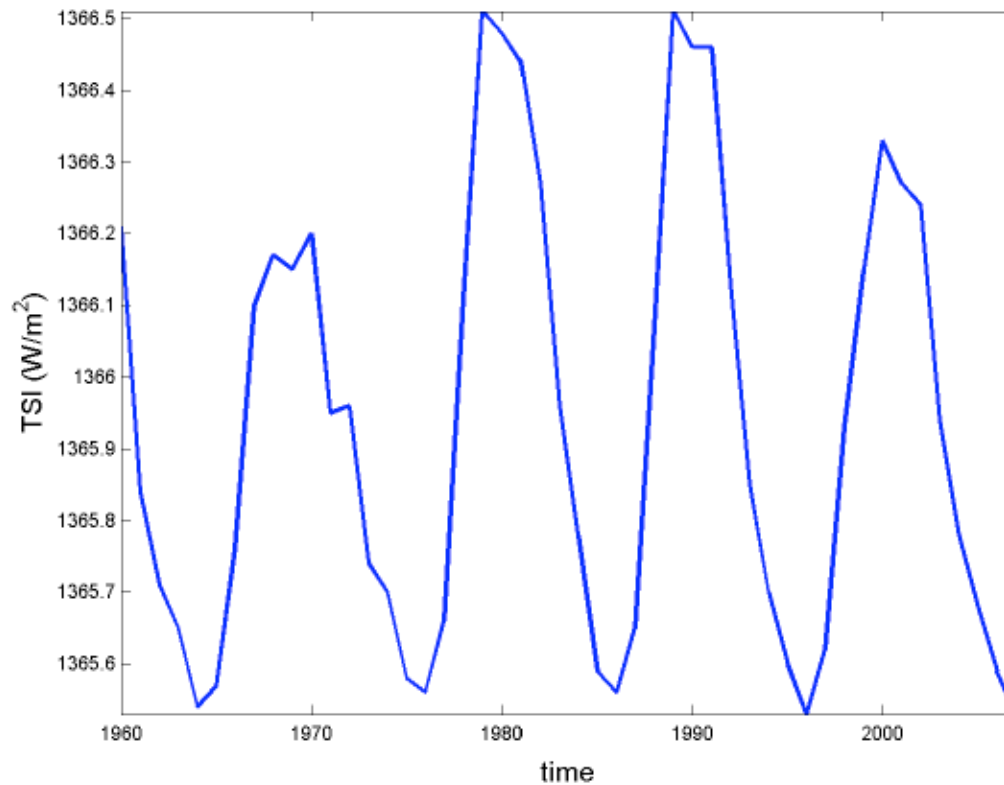
Data

- AIRS L1 B daily zonal mean T using 2388 cm^{-1} ($4.3\text{ }\mu\text{m}$ CO_2 line) in region $0\text{-}20^\circ\text{N}$, clear sky and random
- AIRS L3 data for monthly T at 400 hPa
- NCEP SST
- CO_2 at Mauna Loa

Methods

- Linear Trends
- Empirical Mode Decomposition (Huang & Wu)

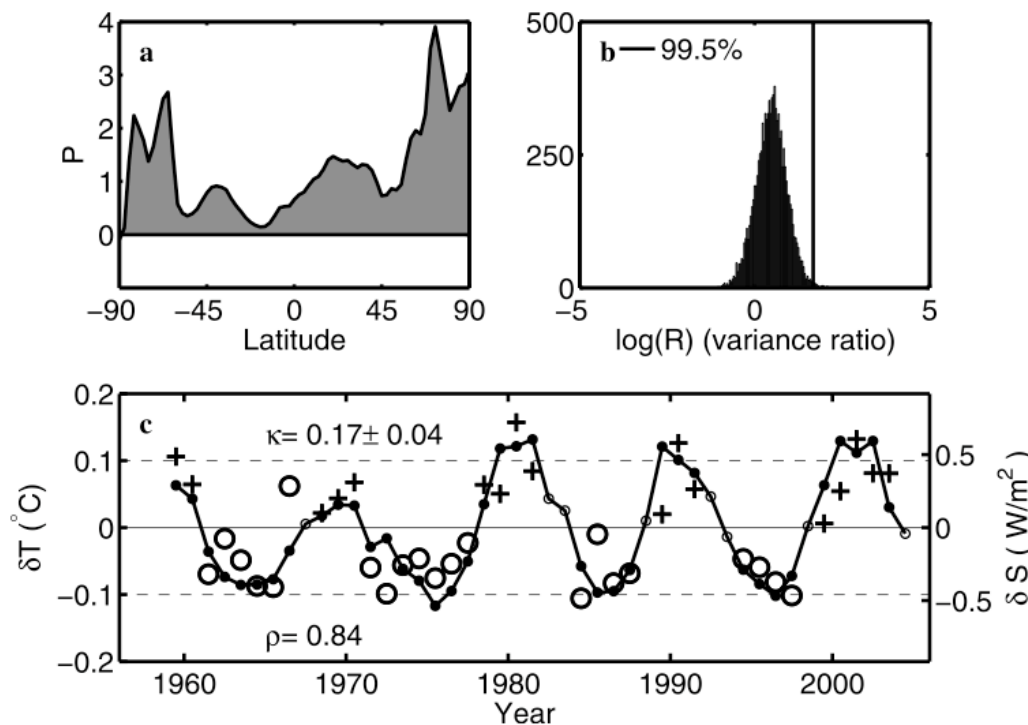
Total Solar Irradiance



- Varies by 1 W/m^2 from solar max to solar min
- Estimated response of the Earth's global temperature 0.1- 0.2K
- Now in the declining phase of the solar cycle

Expected Solar Cycle Effect

TUNG AND CAMP: SOLAR CYCLE WARMING



TC fit $\delta T = k \delta S$
to 4.5 solar cycles

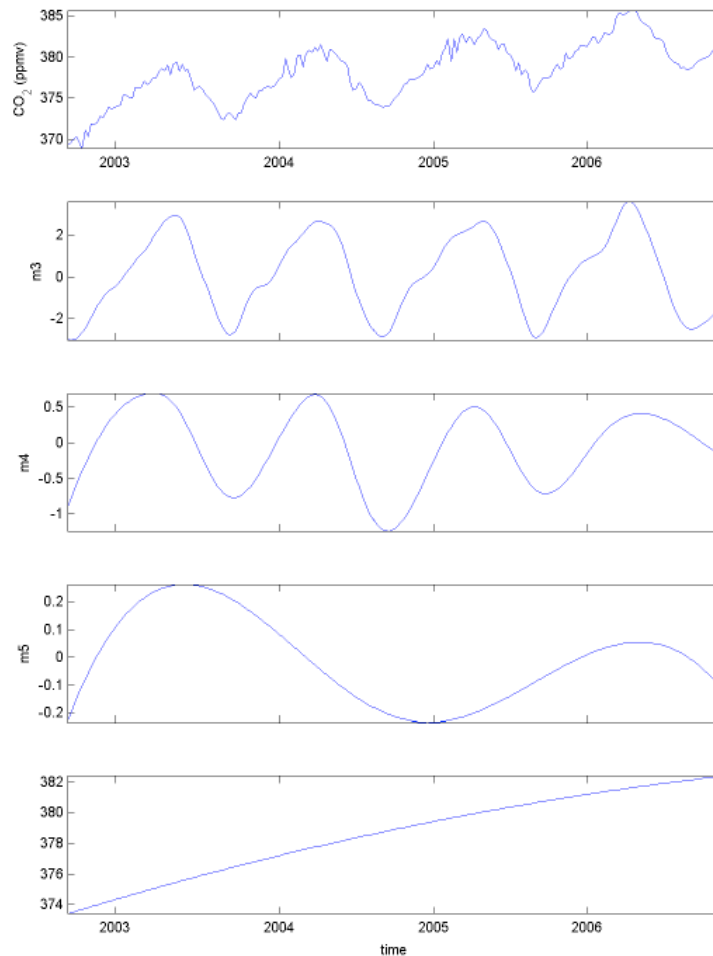
$k = 0.167 \pm 0.037 \text{ K/(W m}^{-2}\text{)}$
at the surface

$k = 0.213 \pm 0.044 \text{ K/(W m}^{-2}\text{)}$
500–850 hPa

(Tung & Camp, JGR, 2008 +)

Expected cooling in 0-20°N is $\sim 0.15 \text{ K}$ for the 5 yrs of AIs (30 mK/year)

CO₂ Trend (MLO)

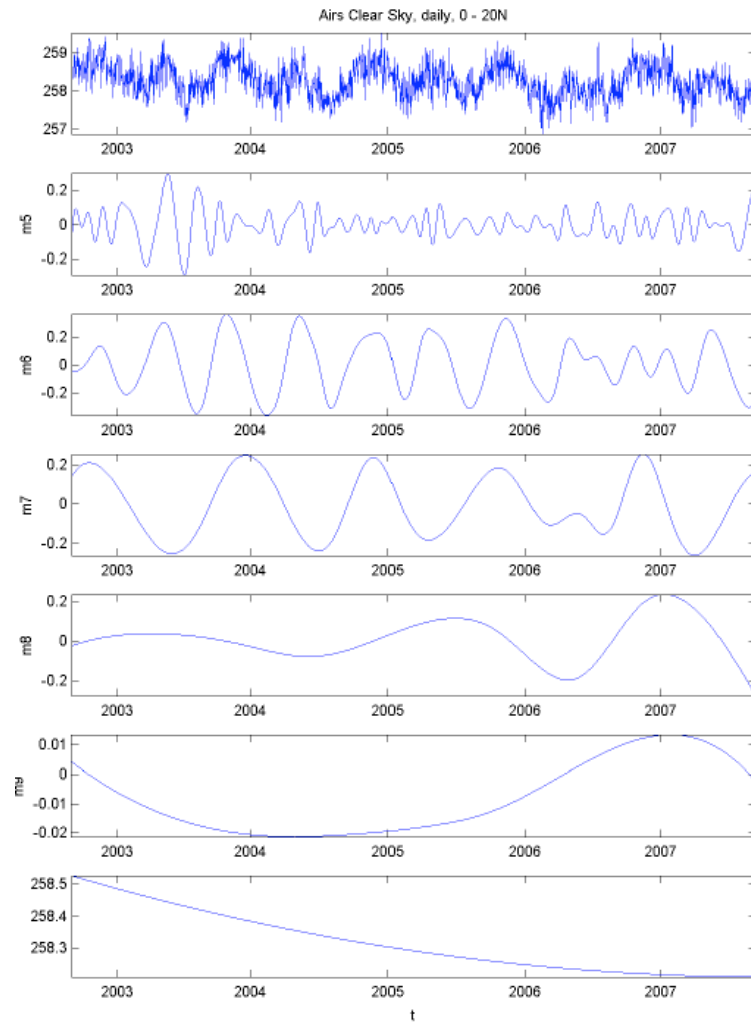


Linear Trend

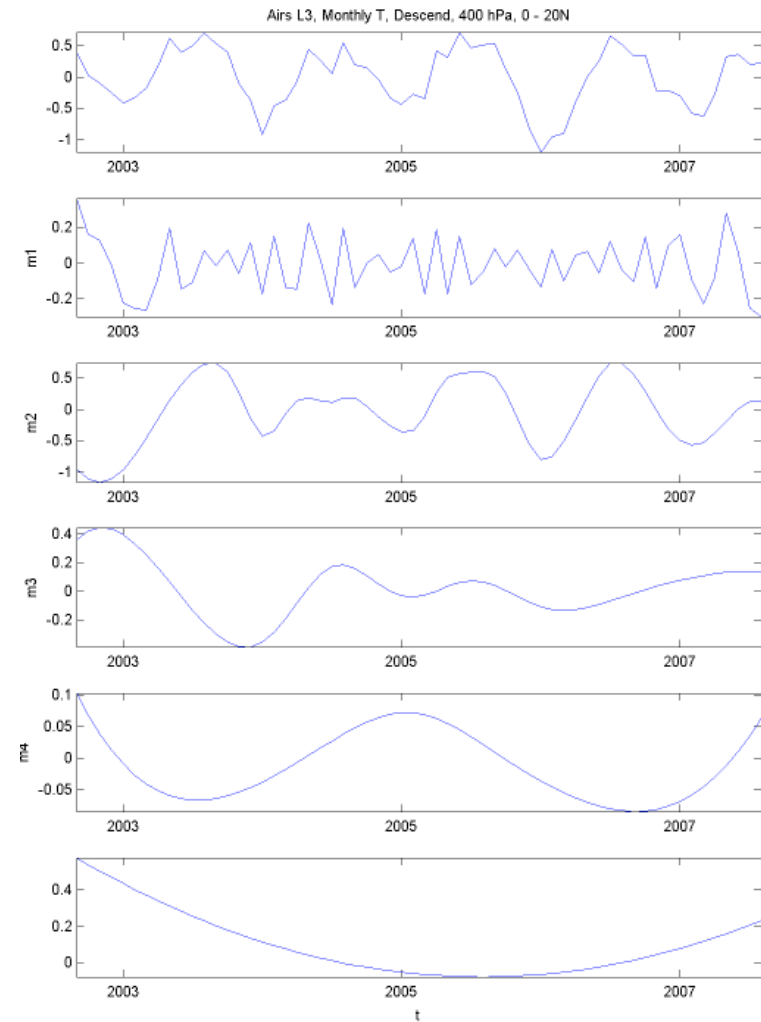
2.06 ± 0.1 ppmv/year
in 2002-2006

Using sensitivity 40 mK/ppmv at
400 hPa gives 80mK/year shift
in weighting function

Airs Clear Sky



Airs L3 Monthly



Linear Fits to Trend

mK/year

Solar expected

-30 ± 7

NCEP Tropical Ocean

-30 ± 7

Airs L3 Monthly

-30 ± 42

Corrected for CO₂ trend

Airs L1 B (clear sky)

-52 ± 7

Corrected for Freq Shift + 10 ± 1

$+28 \pm 9$ Corrected for CO₂ increase + 80 ± 2

Conclusions

- The linear fit to trend from Airs L3 monthly shows solar cooling but error is large
- Effect of solar cycle cooling needs further study with L3 8 day-average
- Clear sky data indicate warming spots ($\sim 1\%$)
- Trends are basically non-linear